

COASTAL PLANNING & ENGINEERING OF NORTH CAROLINA, INC.

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June 25, 2014

John Stockton
Town Manager
Town of Kitty Hawk
101 Veterans Memorial Drive
Kitty Hawk, NC 27949

Subject: Preliminary Overtopping Analysis

Dear Mr. Stockton:

Coastal Planning & Engineering of North Carolina, Inc. (CPE-NC) and the Town of Kitty Hawk executed an agreement on January 14, 2014 to proceed with the design and permitting of a Town wide beach nourishment project. The purpose for implementing a beach nourishment project at Kitty Hawk is threefold. First, is to reduce the vulnerability of public infrastructure including NC 12, Town roads between NC 12 and U.S. Highway 158, and utilities to storm-induced erosion. Secondly, is to reduce flooding experienced in many non-oceanfront areas throughout the Town during ocean over wash conditions, including portions of Highway NC 12 and U.S. Highway 158. This flooding, which at times can render routes impassable, greatly limits the ability for emergency personnel to respond. Thirdly, is to reduce the vulnerability of homes within the Town that front the Atlantic Ocean and are exposed to wave events during nor'easters and other large storm events as well as natural erosional trends.

As part of the scope of work, CPE-NC agreed to develop a Preliminary Overtopping Analysis. The Preliminary Overtopping Analysis is meant to provide specific guidance to the Town and property owners on how to strengthen the existing dune line along the Town's ocean shoreline in order to mitigate overwash and flooding during the interim time period between the present and that time in which the beach nourishment project is constructed. Task 3, Sub-Task D of the Scope of Services describes this analysis as follows:

CPE-NC will conduct a preliminary overtopping analysis to identify specific weaknesses in the existing dune system such as vehicle access points, dune breaks due to homes and other structures, and other low points in the dune system. CPE-NC will use LiDAR data to identify low spots in the dune. CPE-NC will use multiple LiDAR data sets to examine pre- and post-storm conditions of these weak spots.

CPE-NC will coordinate with the Town Public Works Department and North Carolina Department of Transportation (NC DOT) to conduct a site visit of the area to examine weak spots identified via the LiDAR analysis. CPE-NC will provide a letter report to the Town detailing the findings of this preliminary overtopping analysis. Action alternatives that could mitigate some of the overtopping issues in the interim prior to construction of the beach nourishment project will be included for the Town's consideration. In the event the Town wishes to implement any of the alternatives, CPE-NC will provide a separate proposal to provide services associated with implementing the alternative(s). CPE-NC will also incorporate the findings of this preliminary analysis into the design of the beach fill project to mitigate overtopping issues once the beach nourishment project is constructed.

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This letter describes the results of the analysis and provides guidance for interim management strategies to reduce overwash throughout the Town.

LiDAR Analysis:

Dune elevations along the Town of Kitty Hawk were evaluated using LiDAR (Light Detection and Ranging) data collected by the U.S. Army Corps of Engineers (USACE) JALBTCX (Joint Airborne LiDAR Bathymetry Technical Center of Expertise), USGS (U.S. Geological Survey), NASA (National Aeronautics and Space Administration), and NOAA (National Oceanographic and Atmospheric Administration). LiDAR is an optical remote sensing technology that measures the ground elevation or seafloor at relatively high spatial resolutions. LiDAR data are better suited for surveying subaerial platforms since light penetration may be restricted by water clarity. For this reason, only elevations collected along the dry beach and higher (such as dunes) are evaluated.

In the first step of the preliminary overtopping analysis, LiDAR data and aerial photography were used to create a line that best represents the dune line as present in the 2009 and 2012 LiDAR data sets. The line established represents the general location of the dune along the Town of Kitty Hawk during the period between 2009 and 2012. A proprietary script was used to generate elevation values along this line for both the 2009 and 2012 LiDAR data sets. The points were color coded to produce the maps included as Attachment 1. These maps show two separate panes of the same aerial image of the ocean shoreline. The aerial imagery is from October 2012 following Hurricane Sandy. The color coded points are overlain upon the dune line indicating the elevation of the dune line in 2012 in the upper pane and in 2009 in the lower pane.

Site Visit:

On February 21, 2014 Mr. Ken Willson conducted a site visit of the Kitty Hawk Ocean Shoreline with the Town's Public Works Director, William "Willie" Midgett. Mr. Willson and Mr. Midgett reviewed the dune elevation maps generated from the LiDAR data at the public works office. During the review of the map sheets, Mr. Midgett provided Mr. Willson with locations of some of the most problematic areas that are most prone to overwash and flooding. Mr. Midgett noted that there are frequent sand pushing and sand scraping events occurring along most of the oceanfront shoreline of the Town. In a follow up e-mail, Mr. Midgett stated that to date there have been 20 such events in calendar year 2014. The frequency of these events was taken into account in further assessments of the dune elevations.

During the site visit, Mr. Midgett and Mr. Willson drove along the oceanfront shoreline of the Town starting at the North end. Access was gained through the vehicle access point at Byrd Street. The location of each stop along with a brief description of the area and nature of the flooding that occurs is provided below. Attachment 2 includes photographs taken during the site visit.

Site 1 - (The vicinity of 5305 and 5301 Virginia Dare Trail) Despite frequent bull dozer pushing, washover occurs underneath both of these structures during larger storms.

Site 2 - (Public Access point at Byrd Street) During storms the public works department tries to push up sand to raise the elevation of the access; however this area is frequently overtopped. When the area is overtopped, water runs down Byrd Street and onto adjacent lots.

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- Site 3 - (The vicinity of 5123 Virginia Dare Trail) At this location, washover is prone to occur underneath the home. Recently the home was elevated, which may allow for sand to be placed underneath the house to reduce overwash into the road.
- Site 4 - (The vicinity of 4831 and 4829 Virginia Dare Trail) The area between these two homes is prone to overwashing. At the time of the site visit, there was no dune and no point between the road and the ocean where the elevation was higher than the road.
- Site 5 - (Public Access point at Eckner Street) The public access, as well as the areas under the adjacent homes, are prone to overtopping. The public works department tries to push up sand to raise the elevation of the access prior to storms. The house to the north is also a location of overwash. At times, the public works department is able to maintain the public access high enough to avoid overwash at the access; however overwash still occurs around the house to the north.
- Site 6 - (The vicinity of 4607, 4605, and 4601 Virginia Dare Trail) This location is one of the worst areas for inland flooding. This is a public access point. The house to the north is offset seaward from adjacent houses. Neither house adjacent to the access point has any dune structure in front or under the structure.
- Site 7 - (The vicinity of 4505 and 4503 Virginia Dare Trail) When overwash occurs through these properties, the water flows south and west into the properties south of Wilkins Street and west of Virginia Dare Trail (Figure 1).

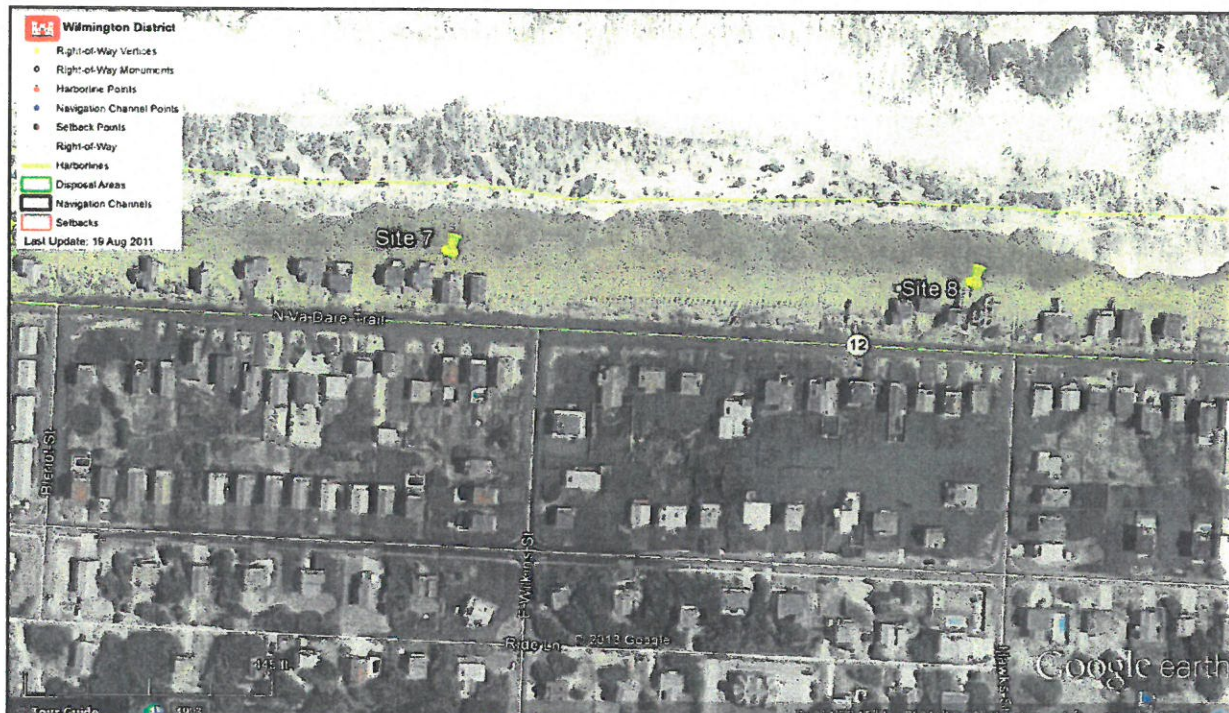


Figure 1. Imagery from Google Earth showing an event that caused extensive flooding in the area landward of Sites 7 and 8.

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Site 8 - (The vicinity of 4407, 4405, 4403, and 4401 Virginia Dare Trail) Areas between properties are relatively low with no dune structure present. Water typically flows between the houses. Flooding is so frequent in this area that the Town has installed a permanent pumpout (See photo IMAG0842), to which a portable pump can be connected to pump out standing water in the area between Virginia Dare Trail and Lindbergh Avenue in the vicinity of Hawks Street.

Site 9 - (The vicinity of 4249 and 4247 Virginia Dare Trail) Overwash occurs around the sides of the two properties. IMAG0851 shows the area between the public access at Balchen Street and the house to the south (Attachment 2). Elevation is very low adjacent to the house. Sand pushed up to the front of the houses in this location.

Site 10 - (The vicinity of 3953 Virginia Dare Trail) This house sits entirely out on the beach. During the off season, a dune forms between the home and Virginia Dare Trail that reduces overwash. However, when the house is being rented, the parking area is on the east side of Virginia Dare Trail, which creates a break in the dune. Property owner is resistant to leaving the dune intact.

Management (Action) Alternatives:

The following list of management alternatives were developed based on information obtained through the LiDAR analysis, conducting the site visit, and interviews with Town staff.

Uniform Dune Elevations: Several of the locations observed during the site visit show that overwash is occurring in areas where dunes fronting structures are being constructed at variable heights and widths. Figure 2 provides an example.



Figure 2. Photograph showing non-uniform dune construction in front of structure.

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The reason for this type of non-uniform construction may be to avoid obstructing access to the stairs or the inability of construction equipment to place material beyond the stairs and under the deck. In order for these constructed dunes to effectively reduce overwash and inundation, property owners should be advised to construct a continuous and uniform dune when conducting sand pushing operations. Likewise, adjacent property owners should coordinate to ensure a uniform transition from property to property.

Adding Material/Truck Haul: The impacts of waves and tides produce a quasi-equilibrium beach profile. When material is scraped from the berm/foreshore and used to reinforce the dunes, the profile of the beach in the vicinity of the berm/foreshore is lowered to a degree that can result in the profile no longer being in a state of equilibrium. Physical forces such as waves and tides will reform the profile resulting in sand being redistributed from adjacent areas both along the profile and up-drift and down-drift along the beach.

Whenever possible, the addition of sand from an outside source is preferred over the removal of sand from the berm/foreshore. The design work CPE-NC is conducting for the dredge and fill project being considered by the Town in cooperation with the County, the Town of Duck, and the Town of Kill Devil Hills includes an evaluation of the most cost effective way to construct the town-wide project given the fact that many oceanfront structures are situated seaward of the primary dune. In the interim if individual property owners decide to truck in sand, the ideal placement location will require a case by case determination. In some areas the prudent approach would be to place sand in front of the structures to form a continuous dune line with adjacent properties (Figure 3). In other locations, placement of sand beneath the structures may be more advantageous (Figure 4).

The addition of sand can be costly due to transportation costs from off island sources. However, the NC DOT routinely plows sand off the road following overwash events. This sand could be placed back onto the dunes with minimal effort. The redistribution of sand plowed from the roadway would require permission from NC DOT to use the sand that is currently located in the right-of-way. Likewise a minor CAMA permit would be required as long as the seaward placement of material was limited to the dune line.

Relocation of Parking Areas: Many of the elevated structures along the oceanfront have a parking space below the structures. The necessity of this parking has deterred property owners from placing sand under the structures to reinforce the dune line and preventing overwash onto the road and inundation of inland areas. Individual property owners should be encouraged to consider alternative parking strategies that would allow for placement of sand and/or sand fencing under structures to create a more continuous dune line to prevent overwash. Some properties may have available space on the west side of the structure to accommodate parking and property owners should be encouraged to do so. Other properties have minimal area to accommodate parking west of the structure as seen in Figure 5 from Site 4. This is also the case for the property located at Site 10 (Pelican's Perch). In cases such as these, property owners should be encouraged to limit parking to one or two cars. Clearly the desire for renters to have parking for more than one or two cars may deter them from selecting such a property; however, the Town could consider some incentives such as free parking passes for renters to use other parking locations in the vicinity.

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Figure 3. Photos of discontinuous dune line illustrating areas in which fill could be placed in front of structures to reinforce the dune and reduce the likelihood of overwash. Panel A. shows a north facing cross sectional view of the dune. Panel B. shows a east facing view of the same dune.



Figure 4. Photograph illustrating areas in which fill could be placed under a structure to reinforce the dune and reduce the likelihood of overwash.

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Figure 5. Photograph illustrating areas under structures that have traditionally been used for parking in which fill could be placed under a structure to reinforce the dune and reduce the likelihood of overwash.

The establishment of a continuous dune or at least an increase in elevation beneath the structures may result in cost savings to the NC DOT, Town of Kitty Hawk, property owner, and adjacent property owners due to the reduction or elimination of the need to repeatedly excavate overwashed sand and damages caused by flooding. Some property owners across the street may be willing to provide parking for renters and property owners of oceanfront structures for the chance at reducing or eliminating overwash of sand and sea water onto their property. Likewise, removal of sand located in the NC DOT right-of-way and placement of the sand along the dunes or under houses may create additional parking.

Raising Driveways/Parking Areas: Houses along certain stretches of the Town of Kitty Hawk, primarily along the southern portion of the oceanfront shoreline, are located seaward of the established dune line. The established dunes in these areas run landward of the houses between the oceanfront structures and NC 12. In order to gain access to these properties, owners have maintained driveways that essentially run through the dune and leave gaps in the dune line (Figure 6). One option that could be considered by individual property owners is the concept of raising the driveway to follow the contour of the adjacent dune. This would allow sand to build up under the driveway and maintain a continuous dune line to mitigate overwash. The cost of such a structure may in some places be prohibitive. The Town should consider any incentives that could be provided to property owners willing to implement such a design as ultimately the Town, NC DOT, and inland property owners would see a reduction in the occurrences of overwash and inundation. In some locations, adjacent property owners could construct one elevated driveway and share access.

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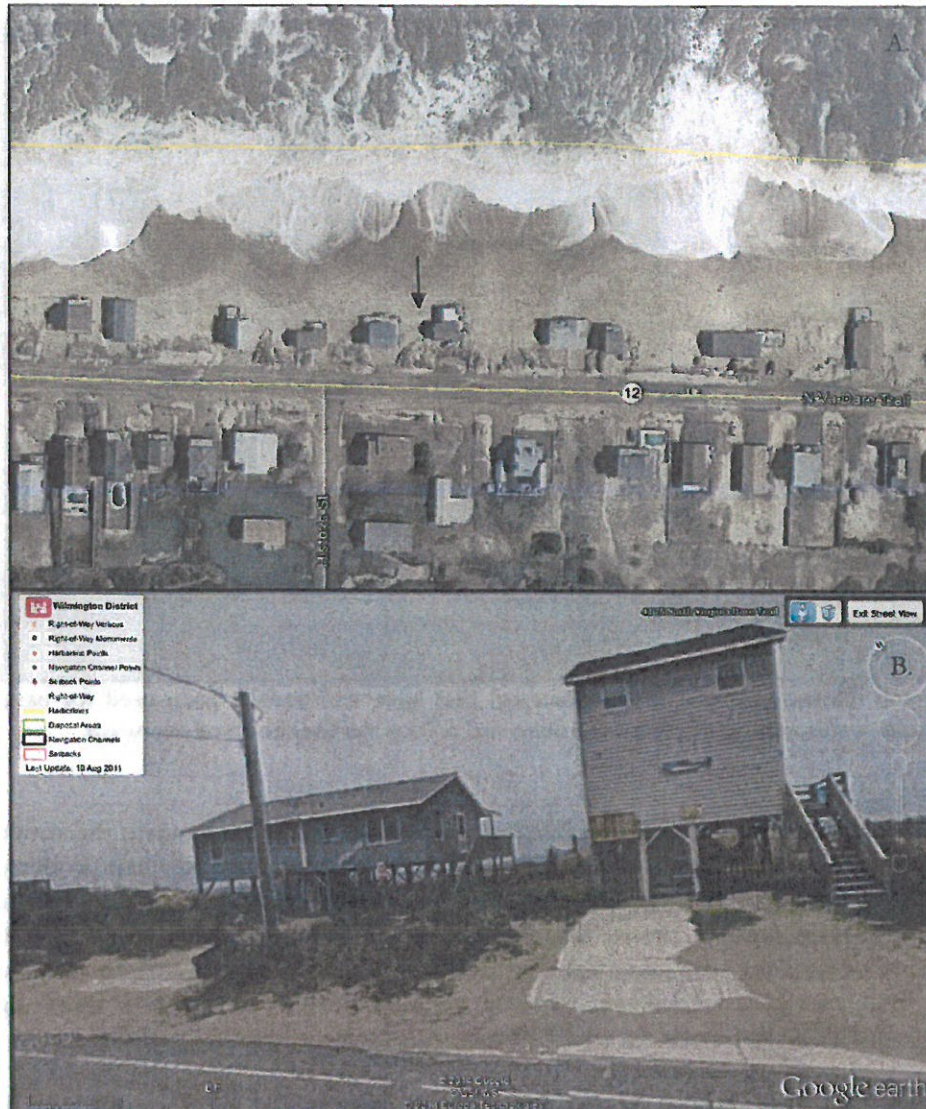


Figure 6. Photograph illustrating areas under structures that have traditionally been used for parking in which fill could be placed under a structure to reinforce the dune and reduce the likelihood of overwash. Location of houses in the lower pane (B) are indicated by the black arrow in the upper pane (A).

In locations such as the emergency vehicle access point at Byrd Street, consideration should be given to raising the grade of the parking area (Figure 7). This option would likely require some preliminary engineering analysis to determine the feasibility of a grade change and whether the number of parking spaces would decrease.

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Figure 7. Photographs of the Byrd Street public access (Site #2). A. East facing view of parking lot and emergency vehicle access. B. West facing view of parking lot and emergency vehicle access.

Modifications to Public/Emergency Vehicle Beach Access: Most of the public beach access locations along the Town are paths across the dunes that are designated for foot traffic. However, five (5) of the public access points have a relatively wide area that is maintained to allow emergency vehicles access to the beach (Figures 7 & 8). According to information provided by the Town's Public Works Department, efforts are made to maintain the path at an elevation at or near the adjacent dune. However, during the spring and summer months, high pedestrian traffic use of the beach access locations can lower the elevation of the sand considerably resulting in a gap in the dune line. The Town should consider installing timber dune walkover structures in locations with the highest traffic. Likewise, in areas where vehicle access is necessary, the Town could consider roping off the portion of the access provided for vehicles to discourage pedestrian traffic through those areas.

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Figure 8. Photograph illustrating the public beach access and emergency vehicle access at Eckner St. (Site #5). Note the low elevation of the public access point and emergency vehicle access point that cross the dune.

The Town should investigate potential beach access grant funding that may be available through the NC Division of Coastal Management. Public access grant application forms are available online at: (<http://www.nccoastalmanagement.net/web/cm/public-access-grant-app>). Likewise, the cost of the walkover structures could be lowered if the Town has qualified carpenters in its public works department. As a point of reference, the Maine Sea Grant has an excellent website on the design and construction of dune walkovers. Although the site is tailored to the State of Maine's rules and regulations, much of the information is applicable to the State of North Carolina (<http://www.seagrant.umaine.edu/coastal-hazards-guide/beaches-and-dunes/paths-and-walkovers>).

At those locations where emergency vehicle access is necessary, the Town should consider the feasibility of installing "Hatteras" ramps (Figure 9). Hatteras ramps have been used in many locations to provide a more solid base for both foot traffic and vehicle traffic through sandy substrate. The ramps are composed of 2 x 4 or 4 x 4 timbers held together by steel cabling. The ramp structures can be configured to multiple lengths and widths and are easily adjusted as sand builds up or erodes from under the structures. Figure 9 shows examples of recently constructed Hatteras ramps. Panel A shows a pedestrian ramp and Panel B shows a vehicular ramp.

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Figure 9. Photographs of Hatteras ramps. A. Pedestrian dune overpass ramp constructed along North Topsail Beach, NC (Photo by: Steve Mercer of Coastal Transplants.) B. Vehicular ramp constructed at access along Carolina Beach, NC (Photo provided by: North Topsail Beach)

Conclusions:

This report describes several action items that if implemented would reduce the frequency and severity of ocean overwash and inland inundation due to coastal storms. These action alternatives are intended to be interim action items to be implemented between now and the construction of the beach nourishment project currently under design. All parties involved must coordinate to determine which proposed management practices are feasible to implement from a financial standpoint. The concepts presented, which include uniform dune elevations, adding material/truck hauling material, relocating parking areas, raising driveways/parking areas, and modifications to public/emergency vehicle beach access points, can reduce the frequency and severity of overwash events. That said, the Town and individual property owners must decide if the implementation of such strategies are feasible.

Please feel free to contact me with additional questions or concerns regarding this matter.

Very truly yours,

COASTAL PLANNING & ENGINEERING OF NORTH CAROLINA, INC.



Tom Jarrett, P.E.
Project Engineer

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